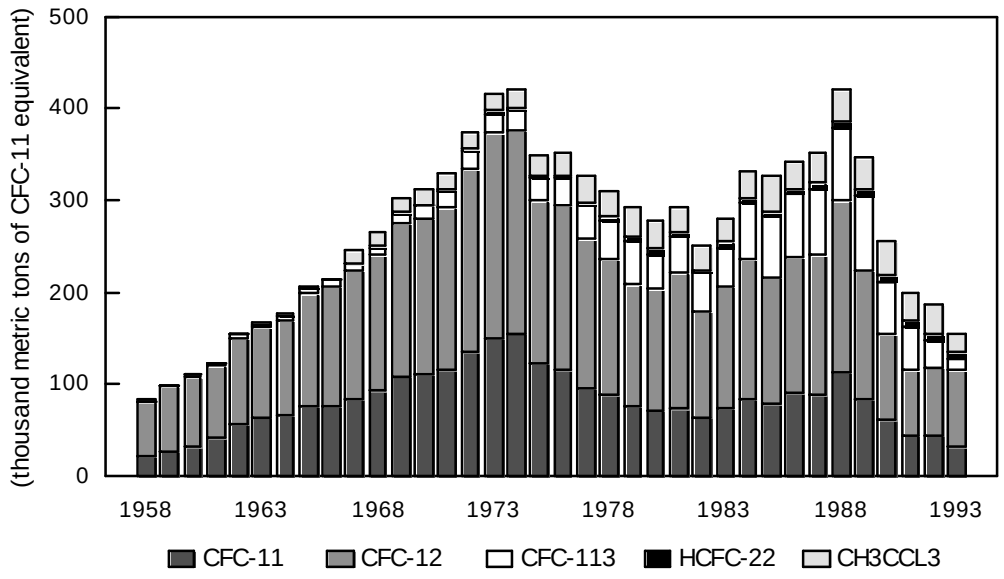
Indicator
U.S. Impact on the Ozone Layer

Figure 1: U.S. Production of Selected Ozone-Depleting Chemicals



Source: U. S. International Trade Commission.

DATA SOURCE

Data on U.S. production of ozone-depleting chemicals such as chlorocarbons CFC-11, CFC-12, CFC-113, and HCFC-22 and CH_3CCL_3 (methyl chloroform) come from the United States International Trade Commission (ITC), *Synthetic Organic Chemicals; United States Production and Sales, 1993,* Table 3-1, pp. 3-19 and 3-21 (Washington, DC: GPO, 1994), and from earlier annual reports in this series. Annual production data through 1993 are published.

Contact Person(s) for U.S. Production of Ozone-Depleting Chemicals:

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DATA COLLECTED AND PURPOSE

The U.S. International Trade Commission reports annually on domestic production and sales of synthetic organic chemicals and the raw materials from which they are made. The report is prepared under investigation No. 332-135, Synthetic Organic Chemical Reports. This investigation is conducted under the authority of section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1322(g)), for the purpose of collecting data and preparing public reports on synthetic organic chemicals, plastics materials, medicinal chemicals, pesticides, and other chemical products. The data are collected by a survey of chemical manufacturers and include the total output of each company's plants, i.e., the quantities produced for consumption within the producing plant, as well as the quantities produced for domestic and foreign sales. Statistics for an individual chemical or group of chemicals are given only when there are three or more producers, no one or two of which may be predominant, and when their publication would not violate the statutory provisions relating to unlawful disclosure of information accepted in confidence by the Commission.

GEOGRAPHICAL COVERAGE

United States.

DATA COLLECTION PERIOD

There is an unbroken time series since 1958 for CFC-11, CFC-12, CFC-113, and HCFC-22 and since 1967 for CH_3CCL_3.

METHOD AND FREQUENCY OF DATA COLLECTION

Data contained in the ITC annual reports are compiled primarily from the Commission's questionnaires sent to domestic chemical producers (643 companies for the 1993 annual report). Data are collected annually.

DATA PRESENTATION

The data for the indicator (Figure 1), which are listed in Table 1, show the total domestic production of CFC-11 and total weighted domestic production of CFC-12, CFC-113, and HCFC-22 for each year from 1958 to 1993 and total weighted domestic production of CH_3CCL_3 for each year from 1967 to 1993.

ITC reports production data in kilograms. For this bulletin, data were converted to metric tons and weighted in terms of their ozone-depleting potential relative to CFC-11. These ozone-depleting potentials are as follows: CFC-11 (1.0), CFC-12 (1.0), HCFC (0.05), CFC-113 (0.8), and CH_3CCL_3 (0.1).

Table 1: U.S. production of selected ozone-depleting chemicals, 1958-1993

(thousand metric tons of CFC-11 equivalent)

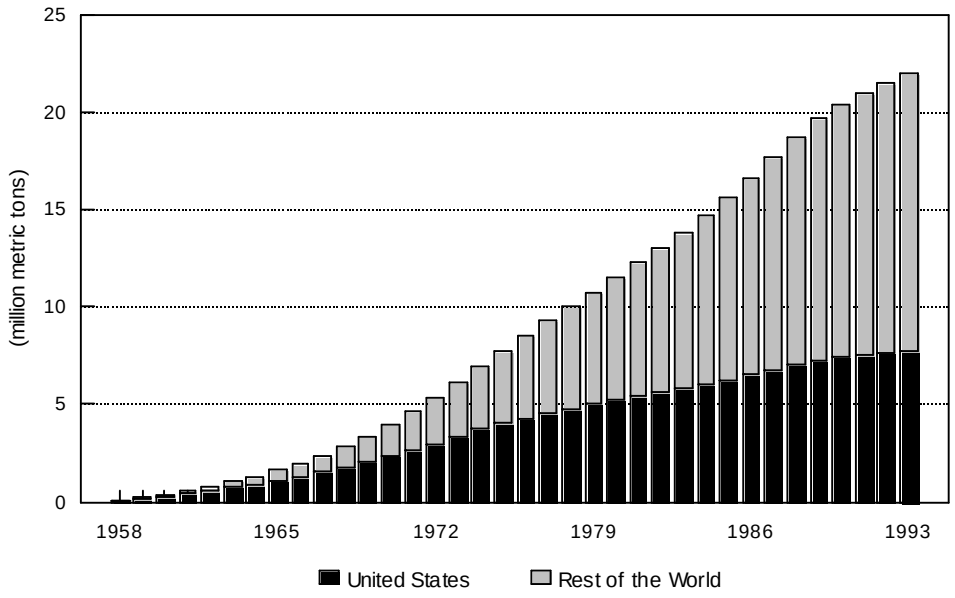
Year	CFC-11	CFC-12	HCFC-22	CFC-113	CH3CCL3
1958	22.9	59.6	0.76	0.0	0.0
1959	27.4	71.3	0.83	0.0	0.0
1960	32.8	75.5	0.91	1.6	0.0
1961	41.2	78.7	1.03	2.4	0.0
1962	56.6	94.3	1.12	3.2	0.0
1963	63.6	98.6	1.23	3.6	0.0
1964	67.4	103.4	1.34	4.3	0.0
1965	77.3	123.1	1.46	5.1	0.0
1966	77.3	129.9	1.59	5.8	0.0
1967	82.7	140.5	1.78	7.6	13.7
1968	92.7	147.7	1.96	9.1	14.6
1969	108.2	166.8	2.14	10.9	15.6
1970	110.9	170.3	2.28	13.1	16.6
1971	117.0	176.7	2.55	15.6	17.4
1972	135.9	199.2	2.80	18.2	18.2
1973	151.4	221.7	3.09	21.4	19.0
1974	154.7	221.1	3.21	23.2	19.9
1975	122.3	178.3	2.99	24.8	20.8
1976	116.2	178.3	3.85	29.7	24.8
1977	96.4	162.3	4.07	36.2	28.8
1978	87.9	148.4	4.67	41.0	29.2
1979	75.8	133.3	4.78	47.0	32.5
1980	71.7	133.8	5.16	36.7	31.4
1981	73.8	147.6	5.71	38.6	27.9
1982	63.7	117.0	3.95	40.0	27.0
1983	73.1	134.3	5.35	42.2	26.6
1984	83.9	152.7	5.76	60.2	30.6
1985	79.7	136.9	5.34	65.8	39.4
1986	91.6	146.2	6.15	69.2	29.6
1987	89.7	151.9	6.23	72.3	31.5
1988	112.9	187.7	7.54	79.2	32.8
1989	83.3	141.2	7.24	80.4	35.5
1990	61.0	94.6	6.94	55.9	36.4
1991	44.9	71.3	7.13	47.2	29.2
1992	45.5	73.9	7.48	28.5	31.4
1993	32.8	83.7	6.61	11.4	20.5

REFERENCE

United States International Trade Commission (ITC), *Synthetic Organic Chemicals; United States Production and Sales, 1993*, Table 3-1, pp. 3-19 and 3-21 (Washington, DC: GPO, 1994), and from earlier annual reports in this series.

Indicator
Cumulative U.S. Impact on the Ozone Layer

Figure 2: Cumulative Production of CFC-11 and CFC-12 by the United States and the Rest of the World



Source: U.S. International Trade Commission and AFEAS.

DATA SOURCE

U.S. production data for chlorofluorocarbons CFC-11 and CFC-12 come from the United States International Trade Commission, *Synthetic Organic Chemicals; United States Production and Sales, 1993*, Table 3-1, p. 3-21 (Washington, DC: GPO, 1994), and from earlier annual reports in this series. Annual production data are summed and cumulative totals calculated for years 1958 through 1993.

Contact Person(s) for U.S. Production of Ozone-Depleting Chemicals:

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Contact Person(s) for Quarterly Data on U.S. Production of Ozone-Depleting Chemicals:

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World production data for CFC-11 and CFC-12 come from the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS), *Production, Sales and Atmospheric Release of Fluorocarbons Through 1993*, Data Tables 2 and 3 (Washington, DC: AFEAS, 1995). Annual production data are reported by participating companies to an independent accountant. Production data are summed and reported for years 1958 through 1993 for the purpose of this bulletin. U.S. cumulative totals (ITC) are subtracted from AFEAS world totals to calculate "rest of the world" totals.

Contact Person(s) for World Production of CFCs:

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DATA COLLECTED AND PURPOSE

The U.S. International Trade Commission reports annually on domestic production and sales of synthetic organic chemicals and the raw materials from which they are made. The report is prepared under investigation No. 332-135, Synthetic Organic Chemical Reports. This investigation is conducted under the authority of section 332(g) of the Tariff Act of 1930 (19 U.S.C. 1322(g)), for the purpose of collecting data and preparing public reports on synthetic organic chemicals, plastics materials, medicinal chemicals, pesticides, and other chemical products. The data are collected by survey of chemical manufacturers and include the total output of each company's plants, i.e., the quantities produced for consumption within the producing plant, as well as the quantities produced for domestic and foreign sales. Statistics for an individual chemical or group of chemicals are given only when there are three or more producers, no one or two of which may be predominant, and when their publication would not violate the statutory provisions relating to unlawful disclosure of information accepted in confidence by the Commission.

Since 1976, the chemical industry has voluntarily reported the production and sales of fluorocarbons through a survey conducted by an independent accountant (Grant Thornton LLP) on behalf of the Chemical Manufacturers Association until 1991 and AFEAS thereafter. The purpose of the survey is to provide the scientific community with data on atmospheric release of fluorocarbons.

GEOGRAPHICAL COVERAGE

In the AFEAS survey, global production of CFCs reflects production by plants in the following countries: Argentina, Australia, Brazil, Canada, the European Union, Japan, Mexico, South America, the United States, and Venezuela. It has been estimated that the data collected for 1993 represents probably less than 75 percent of worldwide production for dispersive uses. Coverage varies from year to year since 1982, as shown in the following table. For years prior to 1982, 100 percent coverage is assumed.

U.S. production reported to ITC is the total quantity of a commodity made available by original manufacturers located within the customs territory of the United States (including the 50 states, the District of Columbia, and Puerto Rico).

World coverage of CFC-11 and CFC-12 production data, 1982-1993

Year	World Coverage	Year	World Coverage
1982	87%	1988	79%
1983	86%	1989	78%
1984	85%	1990	70%
1985	83%	1991	70%
1986	82%	1992	75%
1987	80%	1993	<75%

Source: World Resources Institute (1982-1989) and AFEAS (1990-1993).

DATA COLLECTION PERIOD

For CFC-12, there is an unbroken time series for world production since 1931 and for U.S. production since 1958. For CFC-11, there is an unbroken time series for world production since 1934 and for U.S. production since 1958. Prior to 1958, total cumulative production of CFC-11 and CFC-12 was less than 750 thousand metric tons. For graphical purposes, only data from 1958 forward are displayed.

METHOD AND FREQUENCY OF DATA COLLECTION

Data contained in the ITC annual report are compiled primarily from the Commission's questionnaires sent to domestic chemical producers (643 companies for the 1993 annual report). Data are collected annually.

Data contained in the AFEAS annual report are compiled from questionnaires solicited by the Alternative Fluorocarbons Environmental Acceptability Study and submitted by chemical manufacturers. A listing of all the companies surveyed inclusive of any related subsidiaries and/or joint ventures that may have reported data is contained in each annual report. Sales are divided into use categories, such as refrigeration, foam blowing, aerosols, solvents, and other uses. Some degree of geographical breakdown is also provided. In addition, calculations of atmospheric release of fluorocarbons, based on the survey data, are made. Further detail of data collection and emission estimation procedures and associated uncertainties, and the geographical distribution of emissions has been published (see References below).

DATA PRESENTATION

The data for the indicator (Figure 2) which are listed in Table 2 show the total cumulative production of CFC-11 and CFC-12 for the United States and the rest of the world from 1958 through 1993. See the table above for percent of world coverage in a given year. ITC reports production data in kilograms and AFEAS reports in metric tons. For this bulletin, data were converted to metric tons.

Table 2: Cumulative production of CFC-11 and CFC-12 for the United States and the rest of the world, 1958-1993

(thousand metric tons)

Year	United States	Rest of the World	Total	Year	United States	Rest of the World	Total
1958	82.5	22.9	105.4	1976	4,293.5	4,220.7	8,514.2
1959	181.2	50.2	231.4	1977	4,552.2	4,729.7	9,281.9
1960	289.5	94.4	383.9	1978	4,788.5	5,249.9	10,038.4
1961	409.4	147.4	556.8	1979	4,997.6	5,776.1	10,773.7
1962	560.3	207.5	767.8	1980	5,203.1	6,313.3	11,516.4
1963	722.5	290.5	1,013.0	1981	5,424.5	6,851.2	12,275.7
1964	893.3	407.4	1,300.7	1982	5,605.2	7,424.4	13,029.6
1965	1,093.7	527.6	1,621.3	1983	5,812.6	8,011.1	13,823.7
1966	1,300.9	686.7	1,987.6	1984	6,049.2	8,645.5	14,694.7
1967	1,524.1	876.7	2,400.8	1985	6,265.8	9,329.2	15,595.1
1968	1,764.5	1,099.8	2,864.3	1986	6,503.7	10,070.8	16,574.5
1969	2,039.5	1,356.1	3,395.6	1987	6,745.3	10,908.2	17,653.5
1970	2,320.7	1,652.7	3,973.4	1988	7,045.9	11,697.1	18,743.0
1971	2,614.4	1,986.1	4,600.5	1989	7,270.4	12,426.4	19,696.8
1972	2,949.5	2,363.8	5,313.3	1990	7,426.0	12,933.5	20,359.5
1973	3,322.6	2,792.4	6,115.0	1991	7,542.2	13,443.5	20,985.7
1974	3,698.4	3,267.6	6,966.0	1992	7,661.6	13,860.9	21,522.5
1975	3,999.0	3,708.9	7,707.9	1993	7,778.1	14,226.8	22,004.9

Source: ITC and AFEAS, with world coverage factors applied to AFEAS data.

REFERENCES

Alternative Fluorocarbons Environmental Acceptability Study, *Production, Sales and Atmospheric Release of Fluorocarbons through 1993* (Washington, DC: AFEAS, 1995). Note: This report was published annually by the Chemical Manufacturers Association until 1991. Since 1992, it has been published by the Alternative Fluorocarbons Environmental Acceptability Study.

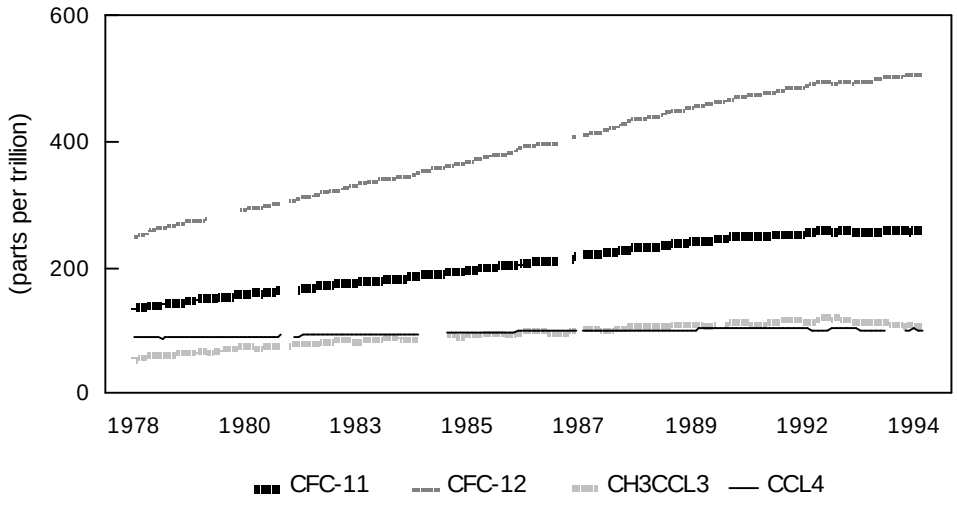
Gamlen, P.H., B.C. Lane, and P.M. Midgely, The Production and Release to the Atmosphere of CCl_3F and CCl_2F_2 (Chlorofluorocarbons CFC-11 and CFC-12). *Atmospheric Environment*, 20: 1107-1085 (1986).

McCarthy, R.L., F.A. Bower, and J.P. Jenson, The Fluorocarbon-Ozone Theory - I. Production and Release: World Production and Release of CCl_3F and CCl_2F_2 (Fluorocarbons 11 and 12) Through 1975. *Atmospheric Environment*, 11: 491-497 (1977).

United States International Trade Commission (ITC), *Synthetic Organic Chemicals; United States Production and Sales, 1993*, Table 3-1, pp. 3-19 and 3-21 (Washington, DC: GPO, 1994), and from earlier annual reports in this series.

Indicator
Atmospheric Concentration of Selected Ozone-Depleting Chemicals

Figure 3: Atmospheric Concentrations of Selected Ozone-Depleting Chemicals



Source: Atmospheric Lifetime Experiment/Global Atmospheric Gases Experiement (ALE/GAGE).

DATA SOURCE

Measurements of the atmospheric concentrations of selected ozone-depleting chemicals come from the Atmospheric Lifetime Experiment (ALE)/Global Atmospheric Gases Experiment (GAGE)/Advanced GAGE network.

Contact Person(s) for Atmospheric Concentrations of Selected Ozone-Depleting Chemicals:

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For information about CDIAC numeric data packages and select data bases, contact:

Sonja Jones
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DATA COLLECTED AND PURPOSE

In the ALE/GAGE/AGAGE global network program, continuous high frequency gas chromatographic measurements of two biogenic/anthropogenic gases (methane and nitrous oxide) and five anthropogenic gases [chlorofluorocarbons $CFCl_3$ (CFC-11), CF_2Cl_2 (CFC-12), and $CF_2ClCFCl_2$ (CFC-113); methyl chloroform, CH_3CCL_3; and carbon tetrachloride, CCl4] are carried out at four globally distributed sites: Cape Grim, Tasmania; Point Matatula, American Samoa; Ragged Point, Barbados; and Mace Head, Ireland. Stations also previously existed at Cape Meares, Oregon, and at Adrigole, Ireland. The program, which began in 1978, is designed to accurately determine the atmospheric concentrations and long-term trends of these important trace gases so that their global circulation rates and globally averaged atmospheric lifetimes can be calculated. The Cape Grim, Tasmania station was selected as the source of data for this indicator as it is both representative and has the longest time series for the complete ALE/GAGE schedule of trace gases.

GEOGRAPHICAL COVERAGE

Global. The Cape Grim data are shown.

DATA COLLECTION PERIOD

Data for CFC-11, CFC-12, and nitrous oxide have been collected fairly continuously at each station since July 1978. Beginning in late 1983 at Cape Grim and later at the other sites, the additional measurements were added to the program. By mid-1986, ALE had ended and was succeeded by GAGE at all sites except the Adrigole (Ireland) station, which closed in December 1983 and was replaced by the GAGE station at Mace Head in January 1987.

METHOD AND FREQUENCY OF DATA COLLECTION

Air samples, collected 4 times daily for ALE and 12 times daily for GAGE, are filtered, dried, and analyzed using Hewlett Packard HP5840A (ALE) or HP5880A (GAGE) electron capture gas chromatographs. The recently initiated Advanced GAGE (AGAGE) uses a custom-designed sample module and HP5890 and Carle Instruments gas chromatographic components.

DATA PRESENTATION

The data from Cape Grim used for the indicator (Figure 3), which are listed in Table 3, show monthly mean halocarbon mixing ratios expressed as parts per trillion by volume. The principal investigators calculated monthly mixing ratios by averaging individual measurements (after removing pollution events). Data are available, in principle, from measurements taken four-times daily for ALE from July 1978 through June 1985 and 12 times-daily for GAGE from December 1981 through June 1994. For CFC-11, individual measurements actually represent averages of the separate

measurements made on two different chromatographic columns when both values are available. For the graphical presentation of the data, in the bulletin gaps caused by missing monthly values were filled with averages.

Table 3: Atmospheric concentrations of selected ozone-depleting chemicals, 1978-1994

(parts per trillion by volume)

CFC-11 (ALE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1978							135.5	137.4	139.0	138.8	141.1	141.3
1979	143.8	144.0	144.2	144.9	145.8	147.0	147.5	148.5	149.5	150.6	151.3	151.6
1980	152.3	153.4	154.4	155.1	157.1	157.9	158.0	158.7	160.4	159.8	161.0	162.2
1981	162.6	161.3	162.5	162.9	164.5	166.0	166.5	na	166.8	na	168.2	168.7
1982	169.3	170.0	171.3	171.8	172.4	174.0	174.6	175.4	176.1	177.3	178.4	178.7
1983	179.2	179.6	179.4	180.0	180.7	181.4	182.3	183.8	184.8	185.5	186.3	187.0
1984	187.2	187.8	188.5	189.8	190.8	191.0	191.9	192.6	193.2	193.4	193.8	194.5
1985	195.0	195.6	196.3	197.7	198.6	198.9						

CFC-11 (GAGE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1981												170.3
1982	170.6	171.0	171.8	172.8	174.0	174.6	175.4	176.4	176.9	177.0	177.8	178.2
1983	178.5	179.5	180.0	180.8	181.6	182.3	183.2	183.0	182.4	183.5	184.0	184.5
1984	184.9	185.4	186.5	188.6	189.5	190.3	191.2	192.0	192.6	193.3	193.8	194.7
1985	195.5	196.0	197.3	198.6	199.2	199.8	200.7	201.8	202.5	203.0	203.8	204.2
1986	204.4	205.0	206.1	207.5	209.1	209.8	210.8	212.0	212.4	212.4	211.8	212.4
1987	213.0	213.3	na	na	218.1	218.8	na	222.5	222.5	223.7	224.4	224.8
1988	225.9	226.5	228.0	228.6	230.2	230.5	231.7	232.6	233.4	234.2	234.0	234.2
1989	234.8	235.3	236.9	238.0	239.0	239.9	240.3	241.2	242.3	243.1	243.4	243.8
1990	244.2	244.8	245.8	246.8	247.1	249.0	249.5	249.9	250.9	251.5	251.8	252.0
1991	251.4	251.0	251.5	252.1	253.0	254.1	254.4	254.6	255.4	256.1	256.3	257.0
1992	256.8	257.6	260.2	260.4	260.7	261.3	260.8	259.8	260.4	261.0	261.4	260.8
1993	259.5	259.2	259.5	259.7	260.1	259.4	259.5	260.0	260.8	261.3	261.6	261.7
1994	261.8	261.8	260.5	260.9	260.8	260.8						

Table 3: Atmospheric concentrations of selected ozone-depleting chemicals, 1978-1994 (continued)

(parts per trillion by volume)

CFC-12 (ALE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1978							251.0	252.2	255.1	257.0	262.7	262.5
1979	265.7	266.4	267.4	268.7	270.6	272.1	272.9	274.7	276.1	276.2	277.5	278.0
1980	279.1	na	na	na	na	na	na	na	294.7	294.9	296.8	297.3
1981	298.5	297.6	299.9	301.6	303.6	305.3	306.0	na	308.5	308.9	310.5	311.6
1982	312.9	313.8	316.2	317.6	318.0	321.2	322.8	324.5	325.3	328.5	330.9	331.3
1983	332.2	334.2	336.2	337.5	338.8	340.5	342.0	342.7	342.9	344.6	345.9	347.0
1984	347.8	349.0	350.3	353.2	357.1	358.3	360.0	361.1	362.2	363.2	364.4	365.2
1985	366.0	367.7	369.4	371.7	373.1	373.9						

CFC-12 (GAGE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1981												315.5
1982	316.9	317.8	319.5	321.5	324.0	325.2	326.3	328.2	329.3	329.8	331.3	331.9
1983	332.6	335.5	337.7	339.1	340.5	341.6	342.9	343.0	342.2	344.0	345.1	345.8
1984	346.2	347.0	348.0	351.8	354.8	355.8	357.1	358.8	358.9	359.8	362.2	365.3
1985	367.6	368.6	370.5	373.0	374.0	375.1	376.6	378.5	379.6	380.7	382.3	383.6
1986	383.8	385.2	386.9	391.8	393.4	395.1	396.5	397.7	399.2	398.5	398.9	399.8
1987	400.7	400.0	na	na	409.3	410.8	na	415.2	415.5	417.5	418.4	419.0
1988	421.1	422.1	424.7	426.1	433.5	433.3	435.7	437.5	438.7	439.9	440.4	441.1
1989	442.3	443.5	445.6	448.2	450.0	451.4	453.2	454.7	456.2	457.5	459.0	460.6
1990	461.4	463.3	465.1	466.6	467.6	468.7	470.1	471.3	473.0	474.4	475.5	476.0
1991	476.3	476.6	477.8	479.5	481.6	482.4	483.6	485.0	487.1	487.9	488.5	489.7
1992	489.9	491.4	494.8	496.0	497.6	498.4	498.2	496.2	496.8	497.5	498.5	498.8
1993	497.0	497.6	498.4	499.0	500.2	500.6	501.3	502.4	504.4	506.4	507.0	507.7
1994	507.6	508.0	508.4	509.4	510.0	510.3						

Table 3: Atmospheric concentrations of selected ozone-depleting chemicals, 1978-1994 (continued)

(parts per trillion by volume)

CH_3CCl_3 (ALE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1978							56.2	54.5	56.0	57.9	61.2	60.6
1979	59.8	59.8	61.4	62.5	62.7	63.8	63.2	64.3	65.2	66.1	66.6	66.3
1980	65.9	66.2	67.4	67.0	70.2	71.0	71.6	72.5	73.5	74.2	74.0	73.1
1981	73.1	73.3	74.6	75.3	75.9	76.4	76.2	na	76.6	78.7	78.9	78.1
1982	77.8	77.8	78.5	79.9	81.4	82.7	83.6	84.1	84.3	85.2	85.2	84.4
1983	84.0	84.0	84.2	84.4	85.4	85.9	87.2	87.5	87.2	87.6	87.5	86.7
1984	86.3	86.3	86.9	87.4	na	na	na	na	na	93.2	92.5	91.7
1985	91.0	90.8	91.3	92.9	93.8	94.4						

CH_3CCl_3 (GAGE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1981												80.8
1982	80.2	80.0	80.1	80.7	81.9	82.8	83.2	84.2	84.2	83.9	83.6	83.2
1983	82.6	83.5	84.5	85.2	86.0	86.4	87.2	88.1	88.1	88.3	88.0	87.5
1984	86.8	86.3	86.9	87.5	88.4	89.4	90.2	91.1	91.4	91.0	91.0	90.5
1985	89.7	89.5	90.3	91.6	92.3	92.7	93.7	95.7	96.6	96.1	95.8	94.9
1986	94.0	93.8	94.4	96.6	97.3	98.3	99.1	99.3	99.9	98.7	97.5	96.9
1987	96.3	95.9	96.5	97.6	98.7	99.8	na	102.1	101.9	102.3	101.8	101.3
1988	100.9	100.3	100.8	101.8	104.4	105.1	105.8	106.4	106.7	106.7	106.7	105.9
1989	105.3	105.4	106.2	107.3	108.2	109.0	109.3	109.8	110.3	110.0	109.4	109.5
1990	108.6	108.7	108.7	109.6	na	111.6	112.2	112.8	113.4	113.5	113.2	112.3
1991	111.3	110.7	111.3	112.2	113.8	114.7	115.1	115.8	116.3	117.0	116.7	116.1
1992	115.1	114.9	115.1	115.5	119.1	120.4	119.9	118.9	119.4	119.0	117.4	115.8
1993	114.4	113.5	113.5	113.6	114.0	114.2	114.5	115.0	114.8	111.8	111.3	109.7
1994	108.6	108.0	108.8	108.4	108.4	108.5						

Table 3: Atmospheric concentrations of selected ozone-depleting substances, 1978-1994 (continued)

(parts per trillion by volume)

CCl_4 (ALE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1978							88.4	87.8	88.3	88.4	88.8	88.4
1979	87.8	87.4	87.7	87.9	87.9	87.7	87.7	87.6	87.6	88.6	88.8	88.9
1980	88.9	89.1	89.5	90.2	90.7	90.6	89.5	89.4	90.1	89.3	90.5	90.4
1981	90.5	89.4	89.8	89.9	90.3	90.8	91.2	na	na	90.5	90.5	90.5
1982	90.8	91.1	91.3	91.5	91.6	92.1	92.1	92.1	92.1	92.6	92.9	92.8
1983	93.0	93.2	93.2	93.3	93.3	93.3	93.3	93.0	92.8	93.0	92.9	93.2
1984	93.2	93.5	93.5	93.8	na	na	na	na	na	95.7	95.5	95.3
1985	95.5	95.4	95.4	95.7	96.0	95.7						

CCl_4 (GAGE)

Mo/Yr	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1981												92.4
1982	92.1	92.2	92.2	92.4	93.5	93.2	93.3	93.4	93.2	92.9	93.0	92.9
1983	93.0	93.5	93.8	94.0	94.0	93.9	93.9	93.9	93.5	93.6	93.6	93.8
1984	93.9	93.9	94.4	95.2	95.2	95.3	95.3	95.4	95.3	95.4	95.5	95.9
1985	96.2	96.3	96.5	96.8	96.9	96.6	96.7	97.1	97.3	97.2	97.4	97.4
1986	97.4	97.5	97.6	98.3	98.3	98.4	98.5	98.3	98.6	98.6	99.0	99.1
1987	99.2	99.5	99.5	99.5	99.6	99.8	na	100.2	100.1	100.3	100.3	100.4
1988	100.7	100.6	100.7	100.9	100.7	101.0	101.0	100.5	100.4	100.4	100.5	100.6
1989	100.7	100.8	101.0	101.1	101.2	101.1	101.2	101.2	101.1	101.1	101.3	102.0
1990	102.1	102.4	102.6	102.3	102.1	102.5	102.4	102.3	102.4	102.3	102.5	102.4
1991	102.1	102.0	102.1	102.1	102.1	102.2	101.8	101.8	101.7	101.8	101.7	101.9
1992	101.8	101.8	100.8	100.9	100.7	100.7	101.1	101.9	101.8	101.7	101.9	101.9
1993	101.8	101.6	101.5	101.4	101.5	101.3	101.1	101.2	101.1	na	na	na
1994	na	100.6	101.5	101.6	101.3	101.2						

na = not available.

Source: Prinn, et al. (1994) and recent updates to database. See References.

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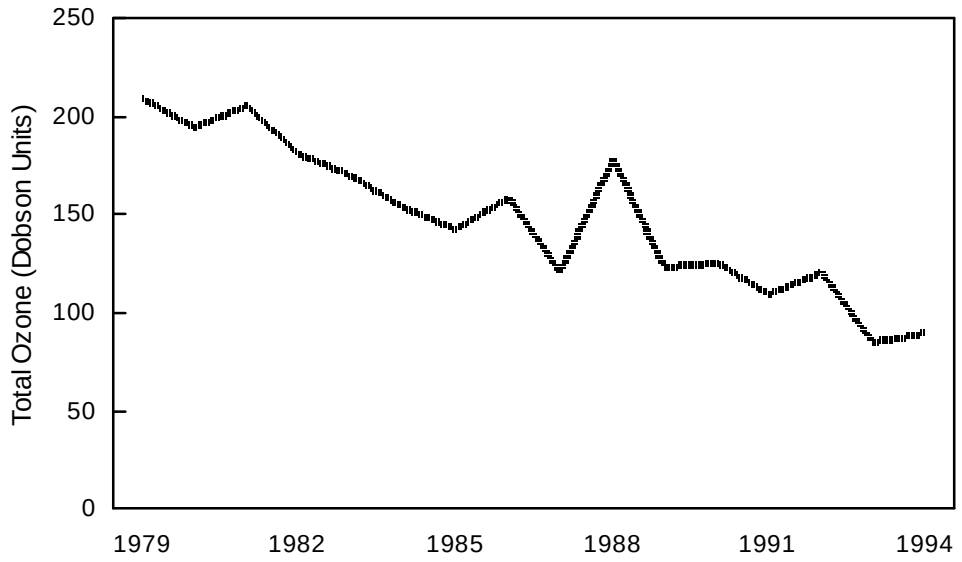
Indicator
Ozone Depletion Over Antarctica

Figure 4: Ozone Depletion Over Antarctica



Source: National Aeronautics and Space Administration (NASA).

DATA SOURCE

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DATA COLLECTED AND PURPOSE

Data are collected on solar radiance and irradiance backscattered by the Earth's atmosphere using the Nimbus-7 satellite. These data are used to calculate total ozone levels, recorded as total ozone mapping spectrometer data (TOMS).

GEOGRAPHICAL COVERAGE

The geographical coverage by the data-collecting satellite is the entire Earth in a south-north orbit synchronized to be either noon or midnight underneath the satellite, changing time at the poles.

DATA COLLECTION PERIOD

The data collection period is an unbroken time series from October 10, 1978.

METHODOLOGY AND FREQUENCY OF DATA COLLECTION

For the purpose of obtaining daily high-resolution global maps of atmospheric ozone, the TOMS system measures the solar irradiance and radiance backscattered by the Earth's atmosphere in six selected wavelength bands in the ultraviolet. A mathematical technique is used to calculate total ozone from the radiances and irradiances. TOMS maps total ozone by scanning, in 3 degree steps, to 51 degrees on each side of the subsatellite path, in a direction perpendicular to the orbital plane. Consecutive cross-scans overlap, creating a contiguous mapping of ozone. The data collection frequency for ozone over the entire world is every 24 hours.

DATA PRESENTATION

Ozone data for the indicator (Figure 4), which are listed in Table 4, show the atmospheric concentration of ozone in the stratosphere over Antarctica. Data are expressed in Dobson Units for the time period 1979 through 1994.

Table 4: Ozone depletion over Antarctica, 1979-1994

(Dobson Units)

Year	Dobson units	Year	Dobson units
1979	210	1987	121
1980	195	1988	179
1981	206	1989	124
1982	182	1990	126
1983	170	1991	110
1984	154	1992	121
1985	143	1993*	85
1986	159	1994*	90

* = Data from Meteor 3 Spacecraft

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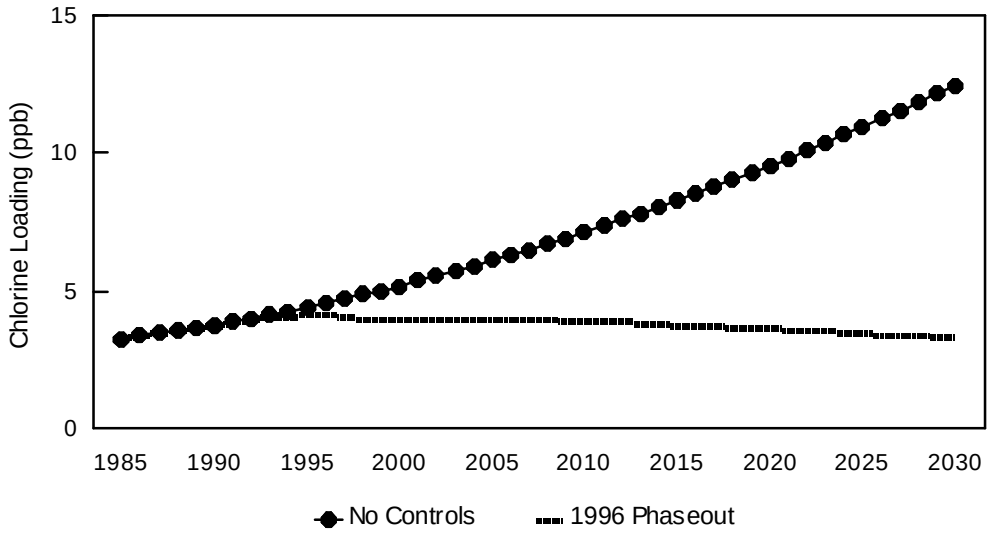
Indicator
Impact of Montreal Protocol on Chlorine Content of the Atmosphere

Figure 5: Adjusted Atmospheric Chlorine Loading



Source: ICF.

DATA SOURCE

Information extracted from industry reports was used as input to a model that generates estimates of chlorine loading to the stratosphere. Industry reports are on file at the U.S. Environmental Protection Agency.

Contact Person(s) for Information on Chlorine Loading to the Stratosphere :

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DATA COLLECTED AND PURPOSE

Data on chlorine loading were not collected, but were generated by a model, based on reported information.

GEOGRAPHICAL COVERAGE

Global.

DATA COLLECTION PERIOD

Model-generated estimates based on reported data are from 1985 through 1991. Later estimates are model-generated forecasts are based on assumptions to 2030.

METHODOLOGY AND FREQUENCY OF DATA COLLECTION

Data were not collected, but generated by the Atmospheric Stabilization Framework (ASF), a model developed during a 1988 workshop sponsored by NASA and EPA. The ASF is documented at NASA. The ASF is not a physical simulation. Rather, it is a parameterized model based on more complicated simulations and calibrated to meet historical measurements of ozone depletion in 1985 and 1989.

DATA PRESENTATION

The data for the indicator (Figure 5), which are listed in Table 5, show adjusted atmospheric chlorine loading in parts per billion (ppb) for the time period 1985 to 2030. One scenario assumes no controls to limit chlorine loading and the other scenario assumes the phaseout of production and consumption of ozone-depleting chemicals in accordance with the Montreal Protocol on Substances that Deplete the Ozone Layer (which entered into force in 1989).

Table 5: Adjusted atmospheric chlorine loading, 1985-2030

(parts per billion)

Year	No Controls	1996 Phaseout	Year	No Controls	1996 Phaseout
1985	3.22	3.22	2008	6.70	3.93
1986	3.34	3.34	2009	6.91	3.91
1987	3.43	3.43	2010	7.13	3.90
1988	3.52	3.52	2011	7.35	3.87
1989	3.62	3.62	2012	7.58	3.84
1990	3.73	3.72	2013	7.81	3.81
1991	3.85	3.83	2014	8.04	3.78
1992	3.98	3.93	2015	8.28	3.75
1993	4.11	4.02	2016	8.52	3.72
1994	4.25	4.08	2017	8.77	3.69
1995	4.39	4.10	2018	9.03	3.65
1996	4.54	4.10	2019	9.29	3.62
1997	4.69	4.05	2020	9.55	3.60
1998	4.84	4.00	2021	9.82	3.57
1999	5.00	3.98	2022	10.10	3.54
2000	5.17	3.97	2023	10.38	3.51
2001	5.36	3.97	2024	10.68	3.47
2002	5.52	3.97	2025	10.95	3.44
2003	5.71	3.97	2026	11.25	3.41
2004	5.90	3.97	2027	11.55	3.38
2005	6.09	3.95	2028	11.85	3.35
2006	6.29	3.95	2029	12.17	3.32
2007	6.49	3.94	2030	12.48	3.29

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TERMINOLOGY

A *chlorofluorocarbon* is one of a group of organic chemicals containing carbon, fluorine and chlorine. CFCs have been used as coolants in refrigerators and air conditioners and as foaming agents, solvents, and aerosol propellants. Chlorofluorocarbons discussed in this technical supplement include CFC-11 (Trichlorofluoromethane), CFC-12 (Dichlorodifluoromethane), CFC-113 (Trichlorotrifluoroethane), and HCFC-22 (Chlorodifluoromethane).

Carbon tetrachloride is an industrial solvent. It is largely used in the manufacture of chlorofluorocarbons and similar chemicals.

A *Dobson Unit* is a unit of measure used to estimate the thickness of the ozone layer. One hundred (100) Dobson units represent a quantity equivalent to a 1 mm thick layer of ozone at sea level.

Hydrochlorofluorocarbons contain hydrogen, in addition to carbon, chlorine and fluorine. HCFCs have many of the same uses as CFCs and are increasingly used as interim substitutes for CFCs. HCFCs retain many of the desirable properties of CFCs but because they exist for a shorter time in the atmosphere, ozone depletion and global warming concerns are significantly reduced.

I*rradiance refers to s*olar light that is reflected in the atmosphere.

Methyl chloroform (1,1,1-Trichloroethane or CH_3CCl_3) is an industrial solvent and metals cleaning agent.

Radiance refers to solar light.